WHAT IS CLAIMED IS:

1. A compact fuel processor for converting a hydrocarbon fuel feed into a purified hydrogen rich gas, comprising:

a reforming stack for converting the hydrocarbon fuel feed into a hydrogen rich gas; and

a purification stack for producing the hydrogen rich gas suitable for direct feed to a fuel cell.

2. The compact fuel processor of claim 1, wherein the reforming stack includes a first plurality of cylindrical vessels, wherein the first plurality of cylindrical vessels are stackable without the need for connecting piping between each vessel; and wherein the purification stack includes a second plurality of cylindrical vessels, wherein the plurality of cylindrical vessels are stackable without the need for connecting piping between each vessel.

3. The compact fuel processor of claim 2, wherein the reforming stack is aligned vertically.

4. The compact fuel processor of claim 1, wherein the reforming stack comprises a shift vessel, an autothermal reforming vessel, and an anode tail gas oxidation vessel; and wherein the purification stack comprises a preferred oxidation vessel, a first desulfurization vessel, and a second desulfurization vessel.

5. The compact fuel processor of claim 4, wherein the hydrocarbon fuel feed is sequentially introduced to:

first, to the anode tail gas oxidation vessel to produce a preheated hydrocarbon fuel feed;

second, to the first desulfurization vessel to produce a desulfurized hydrocarbon fuel feed;

third, to the autothermal reforming vessel to produce a first intermediate hydrogen stream;

fourth, to the second desulfurization vessel to produce a desulfurized intermediate hydrogen stream;

fifth, to the shift vessel to produce a second intermediate hydrogen stream; and

sixth, to the preferential oxidation vessel to produce the hydrogen rich gas.

6. The compact fuel processor of claim 5, wherein the anode tail gas oxidation vessel comprises:

an oxidation core containing a water gas shift catalyst for oxidizing fuel cell anode tail gas to produce a hot exhaust gas; and

a first finned section having a plurality of external vertical fins surrounding the oxidation core for dissipating the heat of reaction produced within the oxidation core;

wherein the hydrocarbon fuel feed is introduced to the first finned section to produce the preheated hydrocarbon fuel feed.

7. The compact fuel processor of claim 6, further comprising a heat exchanger for heating water with the hot exhaust gas to produce a preheated water stream.

8. The compact fuel processor of claim 5, wherein the autothermal reforming vessel comprises:

a reforming core containing an autothermal reforming catalyst for reacting the desulfurized hydrocarbon fuel feed, the preheated water stream, and air to produce the first intermediate hydrogen stream; and

a spiral exchanger section surrounding the reforming core;

wherein the spiral exchanger section contains two channels for preheating the desulfurized hydrocarbon fuel feed with the first intermediate hydrogen stream.

9. The compact fuel processor of claim 5, wherein the shift reactor vessel comprises:

a shift core containing a water gas shift catalyst for reacting the desulfurized intermediate hydrogen stream and water to produce the second intermediate hydrogen stream; and

a second finned section having a plurality of external vertical fins surrounding the shift core for dissipating the heat of reaction produced in the shift core;

wherein the desulfurized intermediate hydrogen stream is preheated in the second finned section prior to being introduced to the shift core.

10. The compact fuel processor of claim 5, wherein the first desulfurization vessel comprises a desulfurization catalyst bed for substantially desulfurizing the preheated hydrocarbon fuel feed to produce a desulfurized hydrocarbon fuel feed.

11. The compact fuel processor of claim 5, wherein the second desulfurization vessel comprises a desulfurization catalyst bed for substantially desulfurizing the first intermediate hydrogen stream to produce a desulfurized intermediate hydrogen stream.

12. The compact fuel processor of claim 5, wherein the preferred oxidation vessel comprises:

a preferred oxidation catalyst bed for reacting air and the second intermediate hydrogen stream to produce the hydrogen rich gas; and

a heat exchange chamber for cooling the hydrogen rich gas with water in a cooling coil

13. A compact fuel processor for converting a hydrocarbon fuel feed into hydrogen rich gas, comprising:

a reforming module for converting the hydrocarbon fuel feed into the hydrogen rich gas, wherein the hydrogen rich gas is suitable for direct feed to a fuel cell; and

an oxidizing module for oxidizing fuel cell anode tail gas to produce a hot exhaust gas, wherein the hot exhaust preheats the hydrocarbon fuel feed to the reforming module.

14. The compact fuel processor of claim 13, wherein the oxidizing module comprises:

a first heat exchanger core;

an oxidation core vessel containing an oxidation catalyst; and

a first desulfurizing vessel surrounding the oxidation core vessel and forming a first annular space filled with desulfurization catalyst; and

wherein the oxidation core vessel oxidizes the fuel cell anode tail gas to produce a hot exhaust gas; and

wherein the hydrocarbon fuel feed is preheated by the hot exhaust gas in the first heat exchanger coil to produce a preheated hydrocarbon fuel feed; and

wherein the preheated hydrocarbon fuel feed is desulfurized in the first annular space to create a desulfurized hydrocarbon fuel feed.

15. The compact fuel processor of claim 14, wherein the oxidation core vessel has a first set of external vertical fins for further preheating the preheated hydrocarbon fuel feed to produce a second preheated hydrocarbon fuel feed, and wherein the second preheated hydrocarbon fuel feed becomes the hydrocarbon fuel feed introduced to the first annular space.

16. The compact fuel processor of claim 13, wherein the reforming module comprises:

a second heat exchanger coil;

a reforming core vessel containing an autothermal reforming catalyst bed;

a second desulfurizing vessel surrounding the reforming core vessel and forming a second annular space filled with desulfurization catalyst;

a shift vessel surrounding the second desulfurizing vessel and forming a third annular space filled with water gas shift catalyst; and

a preferred oxidation vessel surrounding the shift vessel and forming a fourth annular space filled with preferred oxidation catalyst; and

wherein the hydrocarbon fuel feed is preheated by the hydrogen rich gas in the second heat exchanger coil to produce a third preheated hydrocarbon fuel feed; and

wherein the third preheated hydrocarbon fuel feed is sequentially introduced to the reforming core vessel, then to the second annular space, then to the third annular space, and then to the fourth annular space to produce the hydrogen rich gas.

17. The compact fuel processor of claim 16, wherein the hydrocarbon fuel feed is a desulfurized hydrocarbon fuel feed.

18. The compact fuel processor of claim 16, wherein the reforming core vessel has a second set of external vertical fins for further preheating the third preheated hydrocarbon fuel feed to produce a fourth preheated hydrocarbon fuel feed, and wherein the fourth preheated hydrocarbon fuel feed becomes the hydrocarbon fuel feed introduced to the reforming core vessel.

19. The compact fuel processor of claim 16, wherein the third annular space has a third heat exchanger coil for reaction temperature control.

20. The compact fuel processor of claim 16, further comprising an electrical heater for starting up the autothermal reforming catalyst bed.

21. A compact fuel processor for converting a hydrocarbon fuel feed into hydrogen rich gas, comprising:

a heat exchanger coil;

a reforming core vessel containing an autothermal reforming catalyst bed;

a desulfurizing vessel surrounding the reforming core vessel and forming a first annular space filled with desulfurization catalyst;

a shift vessel surrounding the desulfurizing vessel and forming a second annular space filled with water gas shift catalyst; and

a preferred oxidation vessel surrounding the shift vessel and forming a third annular space filled with preferred oxidation catalyst; and

wherein the hydrocarbon fuel feed is preheated by the hydrogen rich gas in the heat exchanger coil to produce a preheated hydrocarbon fuel feed; and

wherein the preheated hydrocarbon fuel feed is sequentially introduced to the reforming core vessel, then to the second annular space, then to the third annular space, and then to the fourth annular space to produce the hydrogen rich gas.

22. The compact fuel processor of claim 21, wherein the reforming core vessel has a set of external vertical fins for further preheating the preheated hydrocarbon fuel feed to produce a second preheated hydrocarbon fuel feed, and wherein the second preheated hydrocarbon fuel feed becomes the preheated hydrocarbon fuel feed introduced to the reforming core vessel.

23. The compact fuel processor of claim 21, wherein the second annular space has a second heat exchanger coil for reaction temperature control.

24. The compact fuel processor of claim 21, further comprising an electrical heater for starting up the autothermal reforming catalyst bed.